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A Theoretical and Empirical Validation of IS Success Models in a Temporal and Quasi Volitional Technology Usage Context

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ABSTRACT
IS implementation success is a critical information systems research issue. This study further extends and assesses both empirically and theoretically prior research on information system (IS) success. Specifically, we examine DeLone and McLean's (1992) seminal model of IS success, and its subsequent refinement by Seddon (1997), and Rai et al. (2002) in a temporal context through a longitudinal study. Our study evaluates the IS success model by examining quasi-volitional use of email to support work requirements. Structural equation modeling is used to analyze data collected from 216 employees of Chinese organizations on their email usage at two different points in time. Our findings are interpreted in the broader context of IS success including the Davis' (1989) Technology Acceptance and Goodhue's (1995) Task-Technology fit models. Our results provide a more comprehensive and in-depth understanding of IS management in a richer context and should help organizations prescribe better strategies in IS management.

Keywords
IS success model, IS implementation, IS Success, IS Management Strategy.

INTRODUCTION
The 1990's saw the widespread acceptance of Information Technology (IT) as an enabler of business value. Pioneering research such as the "Management in the 1990's", a joint research program initiated in the mid 1980's by the MIT Sloan School of Management and major corporations (Scott Morton, 1991) helped spur further research that has successfully argued that IT strategy should be an integral part of the overall business strategy (see Luftman, 1996, for some summary research). Consequently IT, which primarily involves the production and application of computer hardware and software, is now considered a fundamental enabler of a successful business rather than a cost center.

While IT is important for businesses, it is essential that organizations make prudent decisions on IT investments such that the business needs are appropriately, and cost effectively taken care of. A well formulated IT strategy is essential to meet this end. IT strategy become important especially when new IS are to be deployed, and a major strategic concern is whether deployed systems are successful. Thus evaluating implementation success is imperative.

Evaluating IS success has been a focus of MIS research for the past three decades, which can be traced to seminal work of Ginzberg (1978), and Barkin and Dickson (1977) who evaluated success in terms of system usage. However, system usage is just one measure of success, and in certain deployment contexts such as a mandated usage context, system usage might not be the appropriate measure to evaluate success. While research since the 1970's delved into different dimensions of IS success, DeLone and McLean's (D& M) (1992) integrated the various dimensions of IS success into a conceptual framework. This framework has since served as a baseline model for research on IS success.

In this paper, we evaluate the introduction of email to facilitate organizational communication in Chinese organizations. The organizations under consideration made a strategic decision to introduce and encourage email usage to better and augment the existing written and oral communication channels. The organizations did not mandate the usage of the email system; however, social norms to use the system existed making the system deployment context quasi-volitional (quasi-voluntary). We use DeLone and McLean's (1992) baseline model and its subsequent refinement by Seddon (1997) to evaluate the success of email systems in the organizations studied.

Our purpose in this paper is twofold. First, we evaluate the success of email systems using the aforementioned key IS success models. Second, and importantly, we use this research to compare and contrast the DeLone and McLean's (1992) and Seddon

(1997) models of IS success to further add to the body of literature that is accumulating on IS success. IS research has evolved from placing theories in *ad hoc* classification systems, to taxonomies, to currently developing and testing conceptual frameworks (Webster and Watson, 2002). For the IS field to fully mature into a theoretical system, it needs to develop established theories. Critical to this evolution is research replication, where existing models are tested in different context to establish consistency, and hence knowledge (Berthon, et al., 2002). Our second object is towards this end.

Specifically, we replicate and extend Rai et al. (2002) research that compares DeLone and McLean's (1992) and Seddon (1997) models of IS success. While our research provides further confirmation of Rai et al. (2002), it does extend that work in several ways. First Rai et al's study was a static comparison of the models in one time frame. We do a longitudinal comparison, by collecting data on system usage in two time frames. Second, our study focuses on email, a generic technology while Rai et al. focused on a custom built IS for student information management. Third, we study the system deployment across several organizations, while Rai et al's study is limited to one organization. Fourth, though our study inquires the same constructs, we use different items to measure the constructs. Finally, Rai et al's study was set in the US Midwest, while our study is set in China, thus providing a different socio-cultural and technological context. These salient differences we believe provide a richer context for replication and extension.

The rest of the paper proceeds as follows. The next section reviews the DeLone and McLean's (1992) and Seddon (1997) models of IS success. The section following details the study constructs and their measurement. We then present our empirical study. The penultimate and final sections present our discussion and conclusion.

IS SUCCESS MODELS

DeLone and McLean (1992), though a comprehensive study of various attempts to study IS success, identified six key themes in the then extant research. These themes were System Quality, Information Quality, IS Use, User Satisfaction, Individual Impact, and Organizational impact. They then placed these six themes as constructs in a relational model. The relationships were derived from Shannon and Weaver's (1948) classification of evaluating the quality of information that an IS produces into three levels – technical, semantic, and effectiveness, and Mason's (1978) refinement of the effectiveness level into three sub-dimensions. (see Figures 1(page 62) and 2 (page 87) DeLone and McLean, 1992).

The nomological validity of the DeLone and McLean model was thus rooted in the Communication Theory. However, DeLone and McLean did not empirically validate their relational model of IS success. Subsequent empirical validation by other researchers (e.g. Seddon and Kiew, 1994) produced mixed results. Seddon (1997) proposed a respecification of the DeLone and McLean model. Seddon contended that the original model could be interpreted as either a process or a variance model, primarily because the IS Use construct has not been clearly specified. According to Seddon, IS Use can be interpreted as a behavior, a proxy for benefits, or as an event in a process model that leads to individual or organizational impact. His respecified the original model as a variance model with three distinct groups of constructs – measures of information and system quality, measures of net benefits of IS use, and IS use as a behavior. (see Figure 5 (page 245) Seddon, 1997)

With two similar but competing models of IS success, Rai et al. (2002) tested key portions of both models using the implementation and usage of a student information system (SIS) in a US Midwestern university as a the research context. They found that both models exhibited good fit with the data collected. Their key conclusions were as follows: 1) it is important to use an integrated multidimensional dependent measure of IS success (rather than a unidimensional measure) which includes belief, attitudes, and behaviors, thus concurring with DeLone and McLean, 2) the models need to be specified in a given context, and 3) the Seddon model conceptually elaborates the DeLone and McLean model. Rai et al. urge further testing of the 2 models in other contexts.

CONSTRUCT MEASUREMENT

Rai et al. (2002) study focus on all five integral constructs (system quality, information quality, perceived usefulness, user satisfaction, and IS use) of both DeLone and McLean, and Seddon models. We focus on four of these constructs other than information quality in our replication and validation. Information quality is not considered as we believe that the meaning of this construct could be confounded given our research context. The SIS system in Rai et al. generated information that was structured and formal, and hence the quality of information produced in terms of accuracy and relevance could be better judged. In the case of an email system, the information was generated by the users, which followed no formal specifications on the form or content. In this context, users' feedback on information quality could be very different based just on the content of information.

Figure 1 and Figure 2 present the models that are tested in the research. Information quality and its related linkages are not tested and hence are indicated as a dotted box and arrows. The constructs are further explained below.

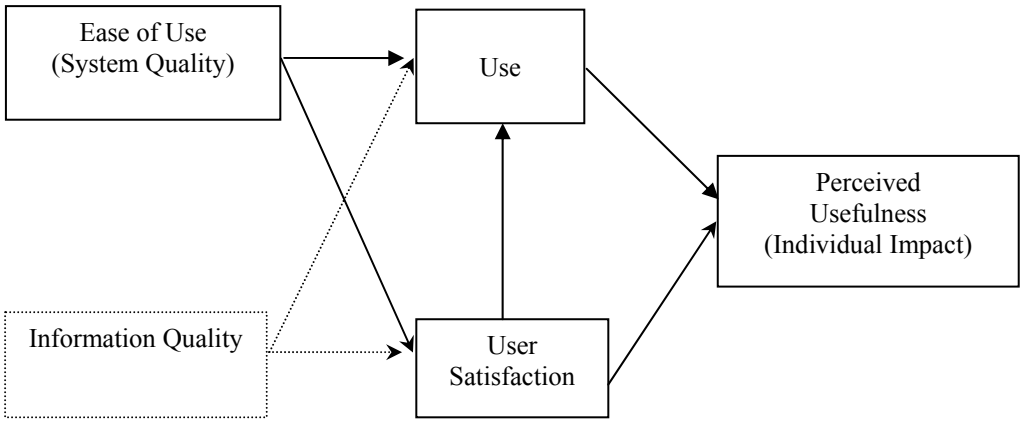


Figure 1. DeLone & McLean Model

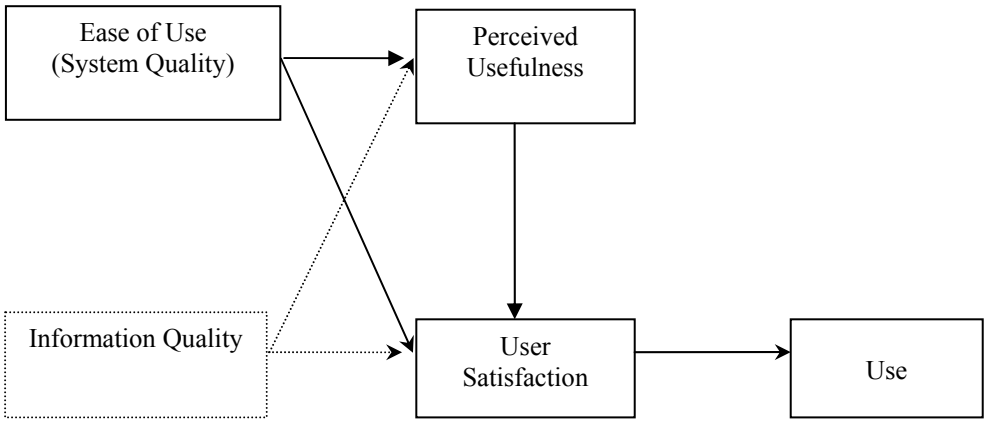


Figure 2. Seddon Model

System Quality

System quality is defined as the degree to which the system is "user friendly", in line with earlier research (Davis, 1989; Doll and Torkzadeh, 1988; Rai, et al., 2002). Hence, we denote System Quality as Ease of Use in this study. Items for the construct were adapted from Davis (1989) and are shown in Table 1.

Perceived Usefulness

Per Seddon, perceived usefulness is defined as "the degree to which the user believes that using a particular system has enhanced her job performance", and the items shown in Table 1 as measures of this construct were adapted from Davis (1989). As in Rai et al. (2002) we include perceived usefulness as a surrogate for individual impact in the DeLone and McLean model, to reflect "personal valuation of IS" which is considered under the individual impact category by DeLone and McLean.

User Satisfaction

Prior research has determined that user satisfaction is related to user attitudes (Igersheim, 1976; Lucas, 1978). User satisfaction measures, consequently, may be biased by attitudes (DeLone and McLean, 1992). DeLone and McLean recommend that the user satisfaction measures should ideally include measures of user attitudes to control for the biasing effects of attitudes. We develop our measures of user satisfaction as attitudinal measures by adapting measures developed by Davis (1989) to our context. Again Table 1 presents our measures for user satisfaction.

IS Use

IS Use was measured using four items from Davis (1989) to reflect "the extent to which users use the system for their work". Table 1 presents these measures.

Construct	Item
Perceived Usefulness	
PU1	Using E-Mail helps me to accomplish tasks more quickly.
PU2	Using E-Mail improves the quality of my work.
PU3	Using E-Mail enhances my effectiveness on the job.
PU4	Using E-Mail makes my job easier.
PU5	Using E-Mail in my job increases my productivity.
PU6	I find E-Mail useful in my job.
System Quality - Perceived Ease of Use (Q-EOU)	
Q-EOU1	Learning to use E-Mail was easy for me.
Q-EOU2	E-Mail is easy to use.
Q-EOU3	It is easy to get E-Mail to do what I want it to do.
Q-EOU4	My interaction with E-Mail is clear and understandable.
Q-EOU5	It is easy for me to become skillful at using E-Mail.
User Satisfaction (SAT)	
SAT 1	Using E-Mail on my job is extremely good … extremely bad.
SAT 2	Using E-Mail on my job is extremely harmful…extremely beneficial.
SAT 3	Using E-Mail on my job is useless ….. Useful.
SAT 4	Using E-Mail on my job is worthless ….valuable.
IS Use (U)	
U1	I use E-Mail a lot to do my work.
U2	I use E-Mail whenever possible to do my work
U3	I use E-Mail frequently to do my work
U4	I use E-Mail whenever appropriate to do my work

Table 1. Construct Measurement Items

EMPIRICAL STUDY

Research Setting

A field research was conducted to collected data used to test the research models. We selected Chinese organizations as the sites for data collection. We selected E-Mail as the technology of interest in our research.

To control for industry effect, we limited our selection to only research and development institutions of similar size. From the pool of 15 companies we selected, six agreed to participate in our study. The organizational units that we investigated were the main organizational unit, the research and development unit.

The research constructs were operationalized based on existing instruments indicated earlier. Because the majority of Chinese employees are not proficient in English, the instrument was first developed in English and then translated into Chinese and back translated to English to ensure that the instrument was equivalent. A pilot study was then conducted in one of the

organizations to validate and refine the instrument. The final instrument contained 19 items for the four constructs as specified in Table 1. The pilot company was not included in the final field study.

The research constructs were measured over a period of one year. Two hundred seventy-four employees from the remaining five organizations participated in the final survey. The participants were given the same survey at two different times, first at time 1 and subsequently one year later time 2. At time 1, of the 274 questionnaires distributed, 49 were not returned and nine were incomplete, resulting in a sample size of 216 (79% response rate). The participants were asked to evaluate the survey questions on fully anchored 7-point Likert scales with end points being "strongly disagree" and "strongly agree." Time 2 yielded a total of 172 returned surveys using the same procedure followed at time 1. Six responses were incomplete thus the sample size was 166 (77% response rate).

Data Analysis and Results

The scale reliability coefficients Cronbach's alpha, shown in Table 2, were assessed for the data collected at time 1 and time 2. All the coefficients are above .80 and above the generally acceptable cutoff (Nunnally, 1967).

Construct Abbreviation	Construct Full Name	Number of Items	Time 1 α	Time 2 α
PU	Perceived usefulness	6	.92	.96
Q-EOU	System Quality - Perceived ease of use	5	.86	.93
U	Use	4	.81	.91
SAT	Satisfaction	4	.86	.97

Table 2. Construct Reliability

Construct validity was assessed by examining the correlation matrices. The within construct correlations were in general higher than between constructs correlations, indicating construct validity (Nunnally, 1967). In addition, we conducted a principal components factor analysis using varimax rotation (Table 3 and Table 4). Consistent with the literature, the items loaded on their respective factors in general with the exception that for time 2 data, there were three items of ease of use cross loaded on the usefulness construct.

Item	Factor 1	Factor 2	Factor 3	Factor 4
PU1	0.81			
PU2	0.85			
PU3	0.88			
PU4	0.78			
PU5	0.77			
PU6	0.73			
Q-EOU1		0.83		
Q-EOU2		0.85		
Q-EOU3		0.72		
Q-EOU4		0.79		
Q-EOU5		0.65		
U1				0.57
U2				0.78
U3				0.77
U4				0.80
SAT1			0.86	
SAT2			0.87	
SAT3			0.85	
SAT4			0.64	

Note: loading below .40 were suppressed.

Table 3. Factor Analysis for the Time 1 Data

Item	Factor 1	Factor 2	Factor 3	Factor 4
PU1	0.77			
PU2	0.78			
PU3	0.81			
PU4	0.85			
PU5	0.81			
PU6	0.77			
Q-EOU1				0.88
Q-EOU2				0.87
Q-EOU3	0.63			
Q-EOU4	0.54			0.72
Q-EOU5	0.51			0.76
U1			0.85	
U2			0.85	
U3			0.87	
U4			0.73	
SAT1		0.88		
SAT2		0.88		
SAT3		0.89		
SAT4		0.86		

Note: loading below .40 were suppressed.

Table 4. Factor Analysis for the Time 2 Data

Table 5 presents the demographic information of the subjects who participated in the survey. The information is based on the data collected at time 1.

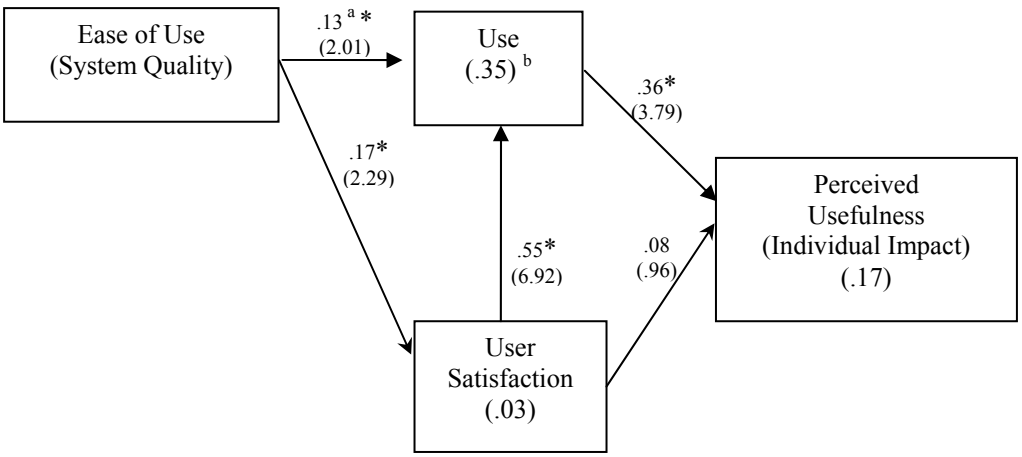
Variables	Sample Composition	Percentage
Age	18-22	6.9%
	23-28	25.1%
	29-34	17.5%
	35-44	25.6%
	45-55	19.5%
	55+	4.1%
	Not reported	1.3%
Gender	Men	69.8%
	Women	26.1%
	Not reported	4.1%
Highest Educational Level Attained	Junior high	0.3%
	High school	1.5%
	Associate degree	22.1%
	College degree	50.0%
	Master's	18.8%
	Doctorate	4.8%
	Not reported	2.5%

Table 5. Sample Demographics

Model Testing

Using structural equation modeling technique, we analyzed the research models. We used LISREL 8.54 to test the model fit. The research models were test in two steps: measurement and structural. The measurement model fit statistics were χ^2 (146 df, N = 216) = 460.45, p < .001, RMSEA = .10, and CFI = .94 for time 1 data and χ^2 (146 df, N = 166) = 766.86, p < .001, RMSEA = .16, and CFI = .93 for time 2. Overall, the statistics were acceptable for structural model assessment.

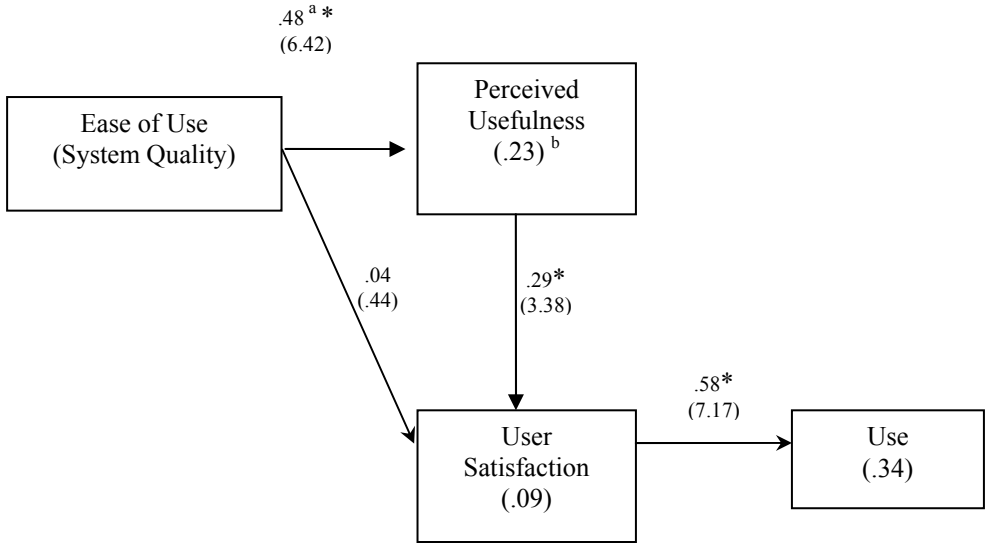
The two different research models were assessed. The Delone & Mclean model fit statistics for the time 1 data were χ^2 (147 df, N = 216) = 503.11, p < .001, RMSEA = .11, and CFI = .93. Figure 3 shows the estimated standardized path coefficients and their *t*-values in the structural model and the variance explained for each of the constructs. All paths were significant at .05 level except the User Satisfaction→Perceive Usefulness link. The model's predictive power is: R^2_{PU} = .17, R^2_{SAT} = .03, and R^2_U = .38.



(a) Coefficient of estimation and (t-value); (b) R^2 value of dependent construct; * $p < .05$

Figure 3. Delone & Mclean Model Estimated – Time 1 Data

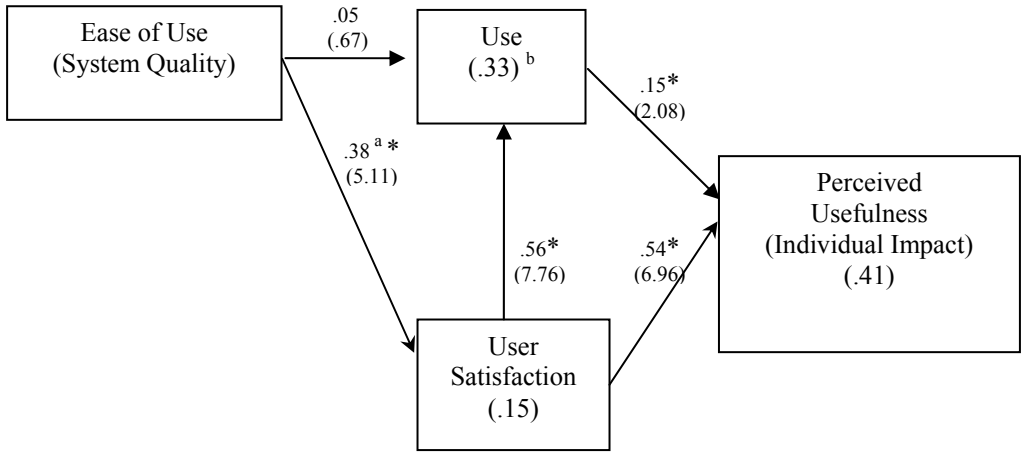
The Seddon model fit statistics for the time 1 data were χ^2 (148 df, N = 216) = 489.73, p < .001, RMSEA = .10, and CFI = .94. Figure 4 shows the estimated standardized path coefficients and their *t*-values in the structural model and the variance explained for each of the constructs. All paths were significant at .05 level except the ease of use→user satisfaction link. The model's predictive power is: R^2_{PU} = .23, R^2_{SAT} = .09, and R^2_U = .34.



(a) Coefficient of estimation and (t-value); (b) R^2 value of dependent construct; * $p < .05$

Figure 4. Seddon Model Estimated – Time 1 Data

The Delone & Mclean model fit statistics for the time 2 data were χ^2 (147 df, N = 166) = 773.18, p < .001, RMSEA = .16, and CFI = .92. Figure 5 shows the estimated standardized path coefficients and their *t*-values in the structural model and the variance explained for each of the constructs. All paths were significant at .05 level except the ease of use→use link. The model's predictive power is: R^2_{PU} = .41, R^2_{SAT} = .15, and R^2_U = .33.

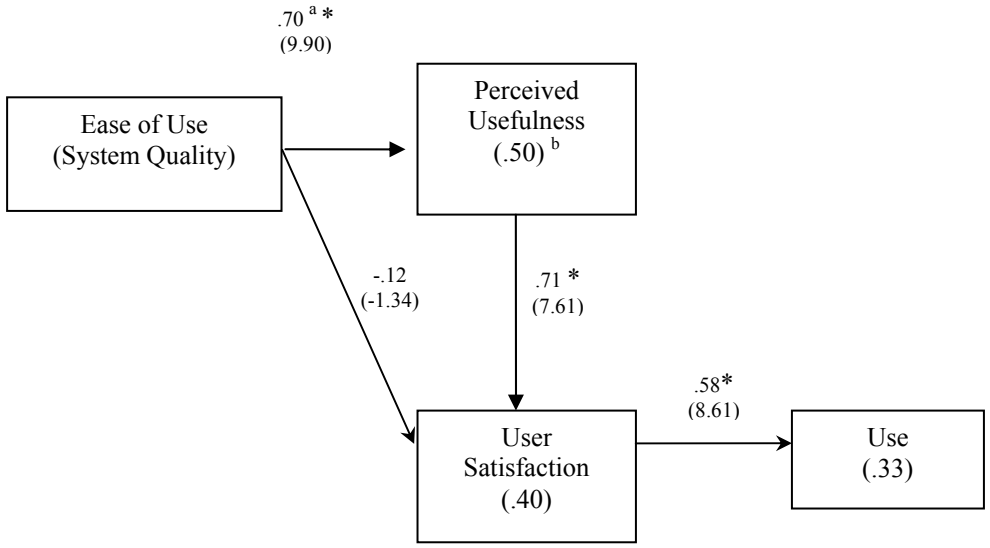


(a) Coefficient of estimation and (t-value); (b) R^2 value of dependent construct; * $p < .05$

Figure 5. Delone & Mclean Model Estimated – Time 2 Data

The Seddon model fit statistics for the time 2 data were χ^2 (148 df, N = 166) = 773.17, p < .001, RMSEA = .15, and CFI = .93. Figure 6 shows the estimated standardized path coefficients and their *t*-values in the structural model and the variance explained for each of the constructs. All paths were significant at .05 level except the ease of use→user satisfaction link. The model's predictive power is: R^2_{PU} = .50, R^2_{SAT} = .40, and R^2_U = .50.

Overall, the structural model statistics indicate adequate fit of the two research models to both data sets.



(a) Coefficient of estimation and (t-value); (b) R^2 value of dependent construct; * $p < .05$

Figure 6. Seddon Model Estimated – Time 2 Data

DISCUSSION

Results of the structural equation modeling analysis presented in the previous section indicate reasonable fit for both DeLone and McLean, and Seddon models. At a broader level, this is similar to Rai et al's (2002) empirical findings and our results further supports the need for a multi-dimensional measure of IS success which is rooted in beliefs, attitudes, and behavior as espoused by DeLone and McLean. However, few deviations at the construct level did surface and are further discussed. The emergence of these differences should not be surprising since ours is a longitudinal study, and the socio-cultural-technological context is different.

To help analyze the difference, we would like to clarify the nature of system usage in our study context. We study the use of the email system where use is routinized in the organization as against being used in an exploration sense. Hence email is not treated as a novelty which only a select set of technologically savvy employees would be interested in using.

For the first time period, the path between User Satisfaction and Perceived Usefulness is not significant in the DeLone and McLean model. This path turns significant in the second time period; however the path between Ease of Use and Use is insignificant in this period. It could be possible that perceptions of usefulness, and user satisfaction are not fully formed during initial stages of deployment. System quality as evidenced by Ease of Use appears to be the larger construct of concern at this stage. With time, Ease of Use does not seem to matter much for system use as evidenced by the insignificant path for the second time period. It appears that as the technology is heavily routinized, users are less concerned with this construct. Also 'network effects' could the prime reason motivating use as time progresses, rather than just Ease of Use.

We have limited our measure of system quality to Ease of Use as espoused in the Technology Acceptance Model (Davis, 1989) literature stream. It is possible that a more complete measure might be needed. For example, inclusion of task-technology fit (Goodhue and Thompson, 1995) as another dimension of system quality might further help shed light on the impact of System Quality on Use and User Satisfaction. The argument here would be that for technology to have impact on performance or any downstream variables, it not only must be easy to use, but should also exhibit a good fit with the task it supports. Thus a component of system quality would be the extent to which the system supports the task to be performed.

The Seddon model appears to be more consistent with the same set of paths being significant for both time periods. Both time periods indicate the following relationship: Ease of Use ➔ Perceived Usefulness ➔ User Satisfaction ➔ Use. Seddon's argument for 3 sets of constructs in IS success models, namely system quality (and information quality), user perceptions of net benefits from use, and system use measured as a behavior is further validated. The path between Ease of Use and User

Satisfaction is insignificant in the Seddon model for both time periods. While this is somewhat surprising, especially the consistency of the insignificance, a possible explanation could be that the components of system quality need to be further explored as noted above.

CONCLUSION

We had a two-fold objective in this paper. First, we wanted to evaluate the strategic decision to introduce email to support work-related communication in Chinese organizations. To achieve this objective, we evaluated the success of the email system using contemporary IS success models. Using multi-dimensional and relational measures of IS success we found, that over a period of time, the system was successfully used. Second, was to replicate and extend empirical validation of key IS success models, specifically the DeLone and McLean (1992), and Seddon (1997) models of IS success. Replication and extension is imperative to help IS discipline move towards developing into an established theoretical discipline. Our research specifically chose to replicate and extend Rai et al. (2002) research to validate the aforementioned IS success models. Our empirical analysis indicated a strong support for Rai et al's contention that both the DeLone and McLean, and Seddon models can explain IS success, and that the use of these models should be context specific. Our research also pointed out some differences, for which we provide plausible explanations; however future research can explore these issues further. Our second object also contributes to IS strategy research, where we provide another confirmation on the appropriate measurement of IS success, which is critical to evaluate strategic IS decisions.

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